# Unit 1 – Matter: Study Guide

| Objectives | |
|---|---|
| 1. Define mass.<br>Define volume.<br>Give appropriate units for each. | |
| 2. Demonstrate that you can use a multiple beam balance to determine the mass of various objects. Record the value of an object's mass in a manner consistent with the limit of precision of the balance. | |
| 3. Represent class data using a histogram; use the histogram to interpret trends in the data.<br>Sketch a sample at right. | |
| 4. Develop, from experimental evidence, the law of conservation of system mass. | |
| 5. Relate the volume of a container (in $cm^3$) to the volume of liquid it contains (in mL). | |
| 6. Recognize that instruments have a limit to their precision; relate the data recorded to the quality of the measurement. | |

| | |
|---|---|
| 7. Round off calculated values to the appropriate number of significant figures. | |
| 8. Given a graph of mass vs volume of a substance, write the equation of the line and state the meaning of the slope. | |
| 9. Recognize that density is a characteristic property of matter . How can density be used to identify unknown substances? | |
| 10. Use density as a conversion factor between mass and volume; show examples of converting mass to volume and vice-versa.. | |
| 11. Use particle diagrams to represent solids, liquids and gases in a way that is consistent with their densities. | |

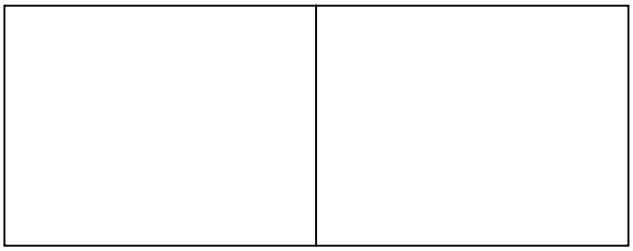
Name_____

Date_____ Pd____

# Unit 1 Worksheet 1: Mass and Change

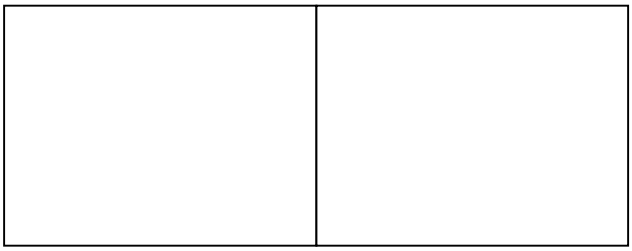
1. When you pulled the steel wool apart, you found that the mass was unchanged. When you heated the steel wool, you found that the mass changed. Explain.

Draw diagrams (at the atomic level) of the steel wool before and after the change.



Steel wool-pulled apart

before after

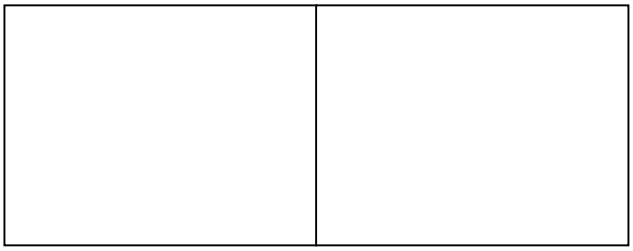


Steel wool-heated

before after

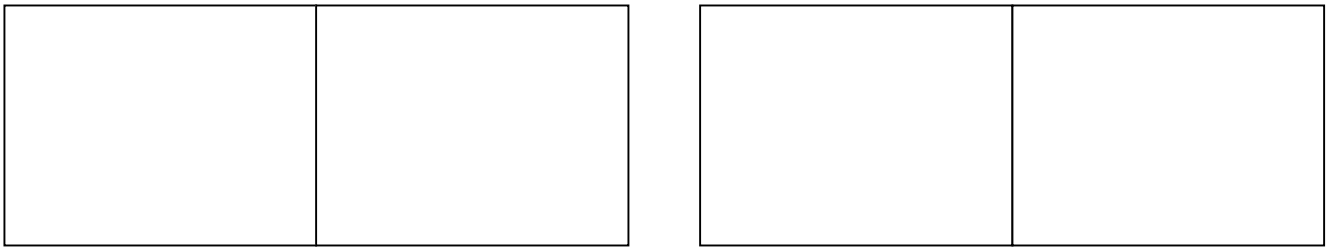
2. When ice melts, the volume of water is smaller than that of the ice. How does the mass of the water compare to the mass of the ice?

Draw diagrams (at the atomic level) of the ice and water. Use small circles to represent the $H_2O$ molecules.



3. When the sugar dissolved in the water, you found that the mass remained unchanged. When the Alka-Seltzer dissolved in the water, the mass of the system changed. Explain.

   Draw diagrams (at the atomic level) of each of the materials before and after it was dissolved.



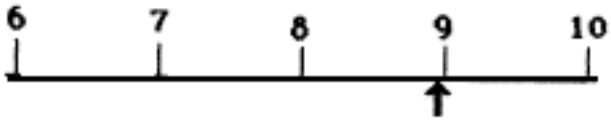
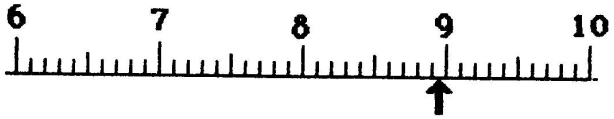
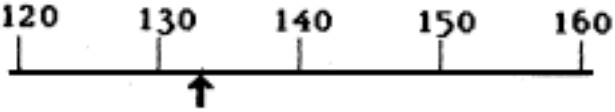
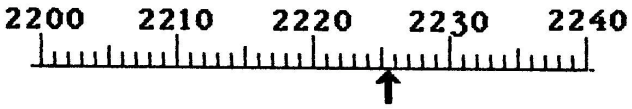
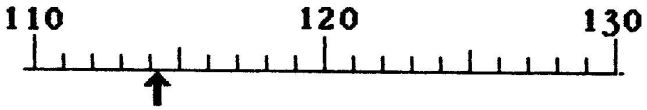
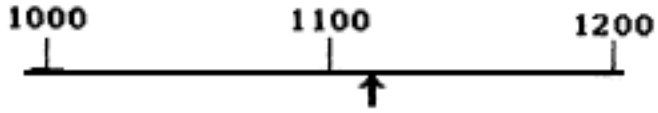
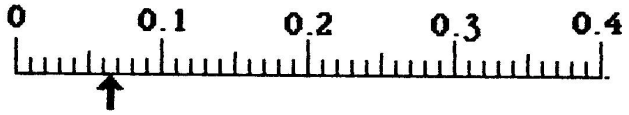
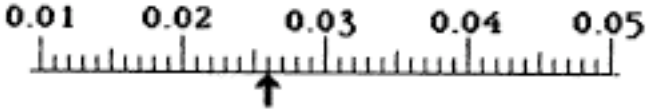
4. State the Law of Conservation of Mass in your own words.

Name _____

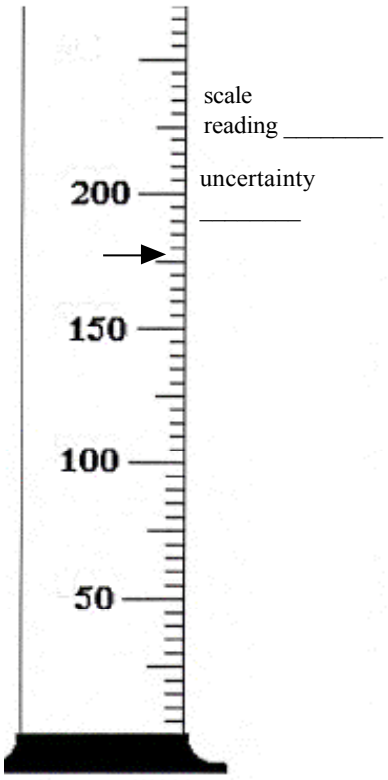
Date _____ Pd ____

# Unit 1: Worksheet 2 - Reading Scales

For each of the following, write the scale reading, then the number of significant figures in the reading.

| | | Reading | SF's |
|---|---|---|---|
| 1. |  | _____ | _____ |
| 2. |  | _____ | _____ |
| 3. |  | _____ | _____ |
| 4. |  | _____ | _____ |
| 5. |  | _____ | _____ |
| 6. |  | _____ | _____ |
| 7. |  | _____ | _____ |
| 8. |  | _____ | _____ |

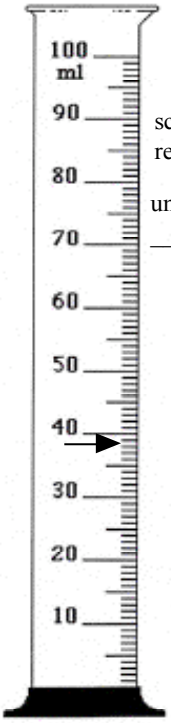
For each of the volume devices below record the scale reading and indicate the uncertainty in the measurement (± _____).




scale reading _____

uncertainty _____

9




scale reading _____

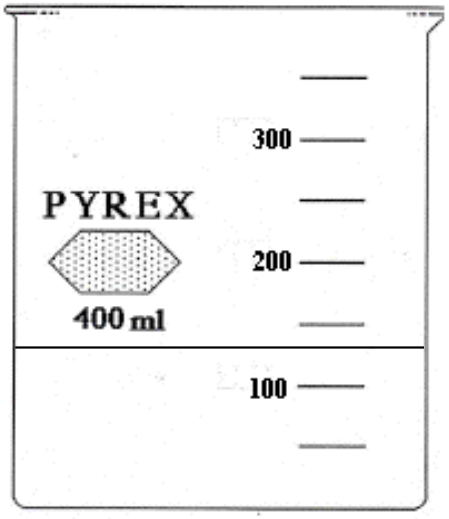
uncertainty _____

10


scale reading _____

uncertainty _____

11




12 scale reading _____

uncertainty _____


scale reading _____

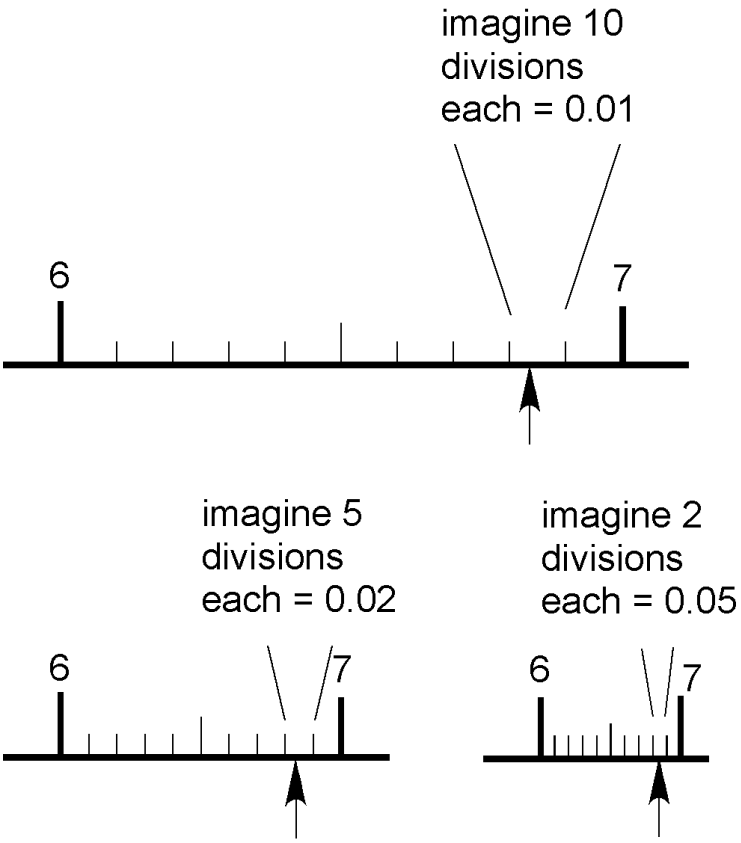
uncertainty _____

13

# Chemistry - Unit 1
# Scale Reading, Uncertainty and Significant Figures

Significant figures – These are all the digits you know for sure + one place that is an estimate.

Uncertainty – Limit of precision of the reading (based on your ability to estimate the final digit). See examples below.




Rules for zeros: All zeros count except placeholder zeros – these are the ones that disappear when you write the number in scientific notation. Examples:

$93{,}000{,}000 = 9.3 \times 10^{7}$ 2 sf's

$0.000372 = 3.72 \times 10^{-4}$ 3 sf's

$0.0200 = 2.00 \times 10^{-2}$ 3 sf's

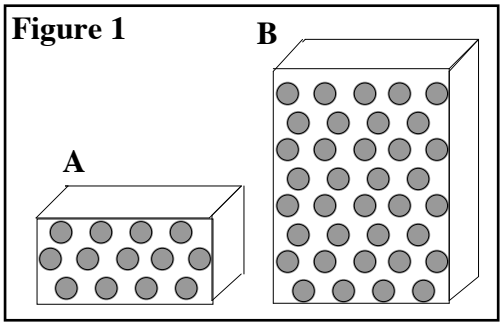
Name _____

Date _____ Pd ____

# Chemistry – Unit 1 Worksheet 3

## Mass, Volume, and Density

1. Study the matter shown in Figure 1. Each dot represents a particle of matter. [*Assume the particles are uniformly distributed throughout each object, and particles of the same size have the same mass.*]

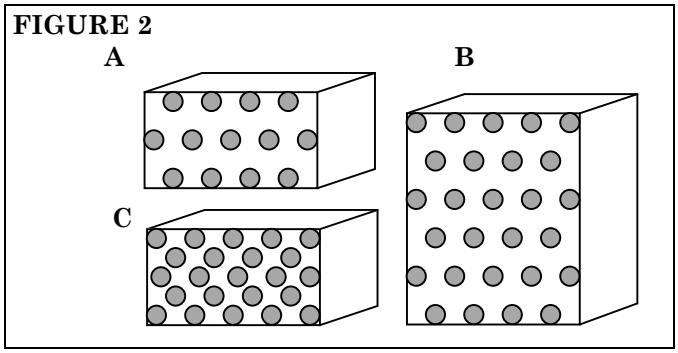



a. In the table below, show how the masses, volumes, and densities of A and B compare by adding the symbol **<, >, or =** to the statement in the second column.

b. Explain your reasoning for each answer in the last column.

| Property | Relationship | Reasoning |
|---|---|---|
| Mass | A ____ B | |
| Volume | A ____ B | |
| Density | A ____ B | |

2. Study the matter in Figure 2. [*Assume the particles are uniformly distributed throughout each object, and particles of the same size have the same mass.*]



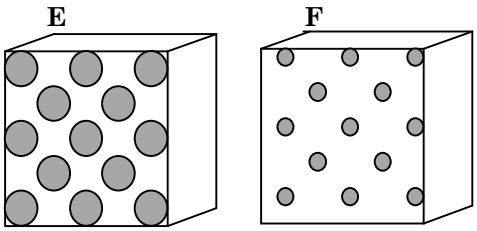

a. In the table below show how the masses, volumes, and densities compare by adding the symbol **<, >, or =** to the statement in the second column.

b. Explain your reasoning for each

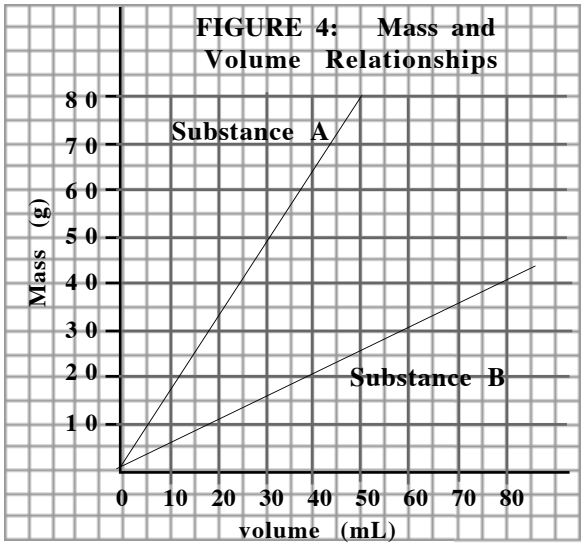
| Property | Relationship | Reasoning |
|---|---|---|
| Mass | A ____ B | |
| | A ____ C | |
| Volume | A ____ B | |
| | A ____ C | |
| Density | A ____ B | |
| | A ____ C | |

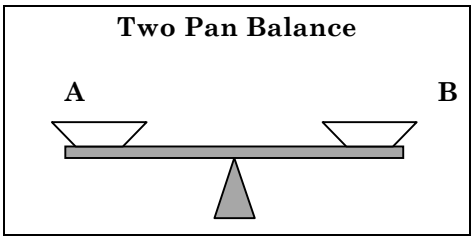
3. Is object E or object F more dense? [*Assume the particles are uniformly distributed throughout each object, and particles with a larger size have a larger mass.*] Explain your reasoning.

**FIGURE 3**




4. In Figure 4 below, a graph shows the relationship between mass and volume for two substances, A and B. Use the graph to answer questions about these two substances.




a) You have built a simple two-pan balance shown abpve to compare the masses of substances **A** and **B**. What would happen to the balance if you put **equal masses** of **A** and **B** in the two pans? **Equal volumes** of **A** and **B** in the two pans? Explain your reasoning.

b) Find the slope of the line for both A and B using correct units. State the physical meaning of the slope for each substance.

c) If you put **10.0 mL of A** in one balance pan, how much **mass of B** would you need in the other pan to make it balance? Explain your reasoning.

d) If you put **35.0 mL of B** in one balance pan, what **volume of A** would you need in the other pan to make it balance? Explain your reasoning.

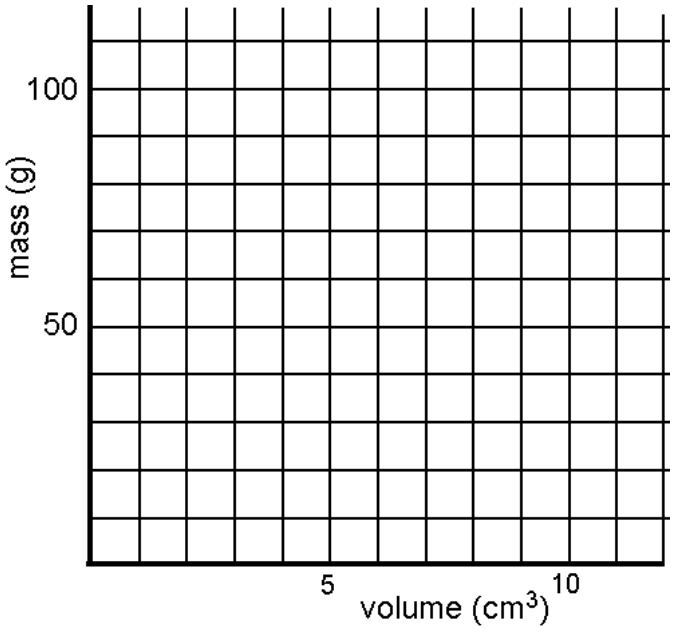
e) Water has a density of 1.00 g/mL. Sketch the line representing water on the graph in Figure 4.

f) Determine whether substance A and B will sink or float when placed in a bucket of water.

**A**: sink float **B**: sink float (circle correct response)

Defend your answer using the m-V graph, and your outstanding understanding of density.

Refer to the table of densities at the right to answer the following questions.




| Substance | Density (g/mL) |
|---|---|
| Aluminum | 2.70 |
| Titanium | 4.54 |
| Zinc | 7.13 |
| Tin | 7.31 |
| Iron | 7.87 |
| Nickel | 8.90 |
| Copper | 8.96 |
| Silver | 10.50 |
| Lead | 11.35 |
| Mercury | 13.55 |
| Gold | 19.30 |

5. Sketch a graph of mass vs volume for titanium, copper and mercury.

6. You made some cubes out of each metal in the table that each measures 2.00 cm on every side. (all except mercury – why can't you make a cube of mercury?)
   a. What is the volume of each cube in **cm³**? in **mL**? (Show your thinking)

   V = _____ $cm^3$ V = _____ mL

   b. Find the mass of these metal cubes: (Show your work below)

   lead cube _____

   nickel cube _____

   zinc cube _____

7. Alicia's cheapskate boyfriend gave her a ring he claims is 24 carat gold. Alicia is skeptical. After chem class the next day she measures the mass of the ring, finds the volume of the ring by water displacement, and then calculates the density of the ring. Should she treasure the ring as his first truly generous gift to her, or throw it at him the next time he walks by? **Defend your answer**.

**DATA:**

| | |
|---|---|
| **Mass:** | **15.28 g** |
| **Final volume:** | **43.7 mL** |
| **Initial volume:** | **42.2 mL** |
| **Volume of ring:** | _____ |
| **Density:** | _____ |

8. A student filled a graduated cylinder with water and read the miniscus at 25.8 mL. The student then dropped a solid material into the graduated cylinder and the water level rose to 35.9 mL. If the solid material had a density of 2.99 g/mL, determine the mass of the solid object.

**Given Find Equation Calculation**

## EXTRA CREDIT

Refer to the table of densities on page 3 of this worksheet to answer these questions:

You have some iron wire, copper wire, and titanium wire (all the same gauge, or diameter). Your lab group measured out a length of wire that is exactly 10.00g for each type of metal wire.

a) Which of these 3 metal wires would be the longest?

b) Which of these 3 metal wires would be the shortest?

c) Explain your reasoning for answers a) and b).

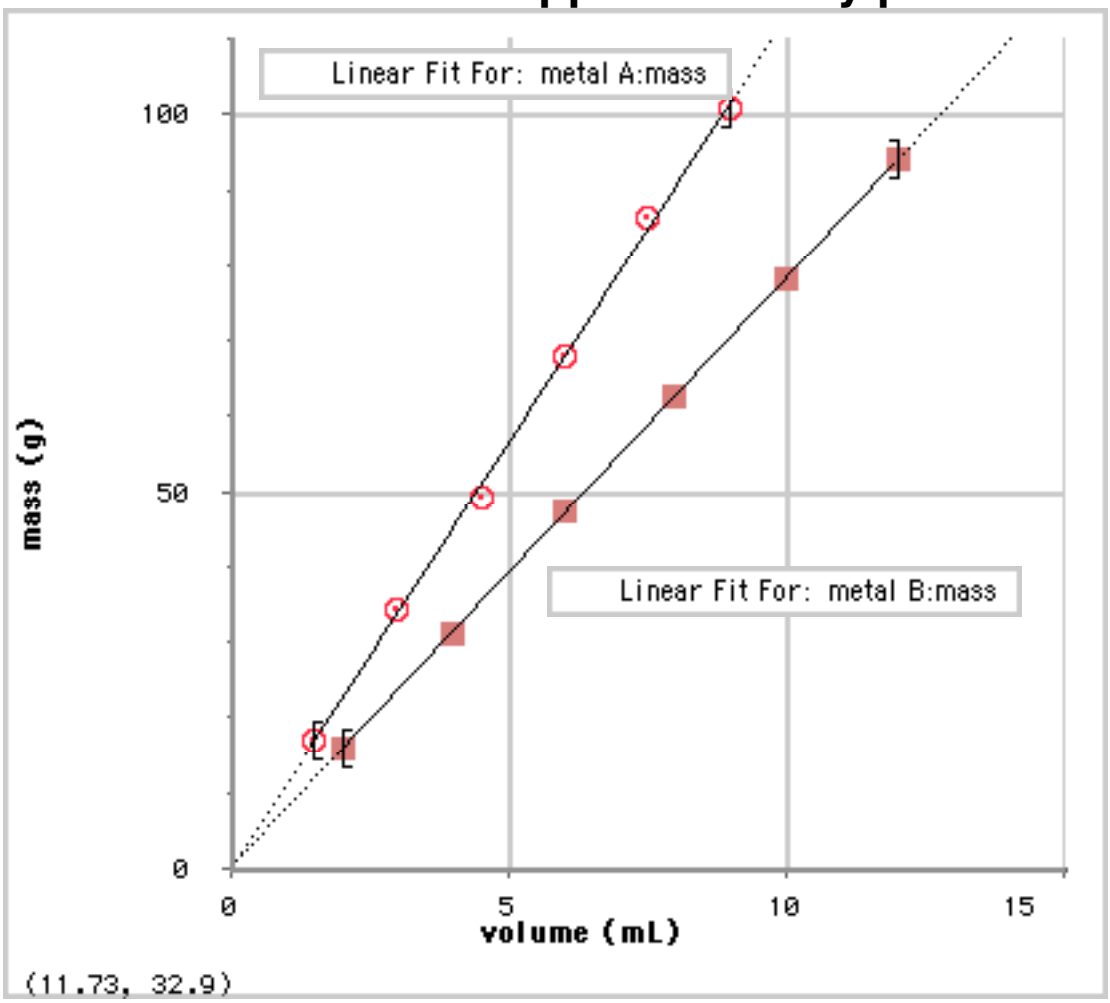
d) If every 1.0 cm length of the titanium wire has a mass of 0.15 g, how long would the 10.00g wire be? (Hint: write a conversion ratio for the two quantities you are working with)

e) What is the diameter of the titanium wire? (Hint: diameter is related to volume; assume it is a cylinder – Geometry! Oh, yeah!)

Name_____

Date_____ Pd____

# Unit 1 Worksheet 4 – Applied density problems




1. Determine the density of each metal. Show all your work and include appropriate units.

2. From the graph, estimate
   a. the mass of 8.0 $cm^3$ of metal A. _____

   b. the volume of 70 g of metal B. _____

   c. mark on the graph how you found the answers above

3. In the space above right, use the density of B as a factor to determine the answer to 2b. Show the set-up including how the units cancel.

4. Ethanol has a density of 0.789 g/cm$^3$.
   a. What is the mass of 225 cm$^3$ of ethanol?

   b. What is the volume of 75.0 g of ethanol?

5. What is the density of water in g/mL? Why?

6. The cup is a volume widely used by cooks in the U.S. One cup is equivalent to 225 cm$^3$. If 1 cup of olive oil has a mass of 205 g, what is the density of olive oil in g/cm$^3$?

7. What would you expect to happen if the cup of olive oil in question 6 is poured into a container of ethanol? Why?

Gold has a density of 19.3 g/ cm$^3$. A cube of gold measures 4.23 cm on each edge:

8. What is the volume of the cube?

9. What is its mass? How many significant figures should you include in your answer and why?

10. A standard backpack is approximately 30cm x 30cm x 40cm. Suppose you find a hoard of pure gold while treasure hunting in the wilderness. How much mass would your backpack hold if you filled it with the gold? An average student has a mass of 70 kg. How do these values compare?

Name _____

Date _____ Pd ____

# Chemistry – Unit 1 – Worksheet 5

## Size of Things

For this worksheet, you will need to go to the site – http://www.vendian.org/howbig/ to answer the following questions.

## Part 1 – Real World

Click on the link to Real World; make sure that you are looking at the sheet of graph paper. Each of the tiny squares on the paper is 1 mm ($10^{-3}$ m) on a side. Examine the objects whose approximate size is given (~ 100 mm means the object is approximately 100 millimeters wide).

1. Using the graph paper as a measuring tool, estimate the diameter of the following in mm:
   quarter _____ golf ball _____ ping pong ball _____

2. Use the ruler below the objects to estimate the diameter of each in inches.
   quarter _____ golf ball _____ ping pong ball _____

3. How long is the 5 Euro bill in mm _____ in cm _____ in inches _____?

## Part 2 – Micro World

Go to the top of the page and click on the *micro* link. Each of the tiny squares on the graph paper is 1 μm ($10^{-6}$ m) on a side. Examine the objects whose approximate size is given (~ 10μm means the object is approximately 10 micrometers wide).

1. Estimate the length of the paramecium in μm. You might have to use the Pythagorean Theorem to find this. _____ Use the conversion factor $1m = 10^6$ μm to change this length to m. _____

   Why is it more convenient to express this value in μm?

2. Lower on the page are some drops from an inkjet printer with a resolution of 1200 dpi. Estimate the diameter (in μm) of such a drop _____

3. Estimate the length of the left-most human chromosone. _____

4. The author shows the thickness of a sheet of aluminum foil.
   What is this in μm? _____Use the conversion factor $1m = 10^6$ μm to change this thickness to m _____

   Now, convert this thickness to cm (1m = 100 cm) How does this compare to the value you obtained?

## Part 3 – Nano World

Go back to the top of the page and click on the *nano* link. Each of the tiny squares on the graph paper is 1 nm ($10^{-9}$ m) on a side. Examine the objects whose approximate size is given (~ 10nm means the object is approximately 10 nanometers wide).

1. Scroll down to find the circle that approximates a globular protein. Estimate the size of a globular protein in nm. _____ Use the conversion factor 1m = $10^{9}$nm to convert this value to meters._____ It would be more convenient to express this value in scientific notation. Do so. _____.

2. Estimate the length (in nm) of a single wall nanotube, an engineered molecule containing carbon atoms

3. Roughly how many times larger is the smallest virus than a buckyball?

## Part 4 – Kilo World

Go back to the top of the page and click on the *kilo* link. Each of the tiny squares on the graph paper is 1 kilometer ($10^{3}$ m) on a side. Examine the map of a portion of Massachusetts.

1. Estimate the distance (in km) between Boston and Cambridge. _____

2. Scroll down to find the ruler. Use the ruler on the sheet to determine a conversion factor between miles and kilometers.
   _____ km = _____ miles

3. Scroll down to the next map. Estimate the length (in km) of Nantucket Is. _____. Use the conversion factor from above to change this length to miles _____

   If you could walk a mile in 30 minutes, how long would it take you to walk the length of this island? Show work.

4. Lower on the page is a satellite photo of a portion of the Rodeo-Chediski fire. Nearly 300,000 acres of forest burned. Use the green square of the page to convert this area to $km^{2}$. Show your work, including your conversion factor.

Name _____

Date _____ Pd ____

# Chemistry – Unit 1 - Worksheet 6

## Dimensional Analysis

Use the factor-label method to make the following conversions. Remember to use the appropriate number of sf's in your answer.

### Part 1

1. 74 cm x _____ = _____ meters

2. $8.32 \times 10^{-2}$ kg x _____ = _____ grams

3. 55.5 mL x _____ = _____ $cm^3$

4. 0.00527 cal x _____ = _____ kilocalories

5. $9.52 \times 10^{-4}$ m x _____ = _____ micrometers

6. 41.0 mL x _____ = _____ liters

7. $6.0 \times 10^{-1}$ g x _____ = _____ mg

8. $8.34 \times 10^{-9}$ cg x _____ = _____ g

9. $5.0 \times 10^{3}$ mm x _____ = _____ m

10. 1 day x _____ x _____ x _____ = _____ seconds

11. $5 \times 10^{4}$ mm x _____ x _____ = _____ km

12. $9.1 \times 10^{-13}$ kg x _____ x _____ = _____ ng

13. 1 year x _____ x _____ = _____ hours (approximately)

14. 4.22 cL x _____ x _____ = _____mL

15. 1 mile x _____ x _____ = _____ inches

## Part 2

1. How many nickels could you trade for 250 yen? $1 = 150 yen.

2. Your school club sold 600 tickets to a chili supper. The chili recipe for 10 persons requires 2 teaspoons of chili powder? How many teaspoons of chili powder will you need altogether?

3. How many cups of chili powder will you need? Three teaspoons (tsp) equal one tablespoon (TBS) and 16 tablespoons equal 1 cup.

4. How many seconds in a year? (assume 30 days in an average month)

5. Chloroform is a liquid once used for anesthetic. What is the volume of 5.0 g of chloroform.
   The density of chloroform 1.49 g/mL

6. How many inches long is a football field?

7. How many $m^3$ is 4.6 $cm^3$.? Express your answer in scientific notation.

8. How many mg is 59.0 kg? Express your answer in scientific notation.

## Metric Conversions With Algebra

## Or King Henry is Dead

| Name | Symbol | Size | factor | or |
|---|---|---|---|---|
| nano | n | $10^{-9}$ | $\frac{10^9 nm}{1m}$ | $\frac{1m}{10^9 nm}$ |
| micro | μ | $10^{-6}$ | $\frac{10^6 \mu m}{1m}$ | $\frac{1m}{10^6 \mu m}$ |
| milli | m | $10^{-3}$ | $\frac{10^3 mm}{1m}$ | $\frac{1m}{10^3 mm}$ |
| centi | c | $10^{-2}$ | $\frac{10^2 cm}{1m}$ | $\frac{1m}{10^2 cm}$ |
| | | | | |
| kilo | k | $10^3$ | $\frac{1km}{10^3 m}$ | $\frac{10^3 m}{1km}$ |
| Mega | M | $10^6$ | $\frac{1Mm}{10^6 m}$ | $\frac{10^6 m}{1Mm}$ |

Start with a number fact, such as 4.1 cm or 0.075 mL. Examine the units of the desired answer. Multiply your fact with the factor $\frac{what\ you\ want}{what\ you\ have}$. The starting units cancel out and you end up with the desired units. Some conversions require more than one factor; e.g. we do not convert directly from kg to μg. So, the best approach is to convert from kg to g (the base unit) then from g to μg.

Remember, even though we write factors with *x* signs, we multiply by the numerators and divide by the denominators.

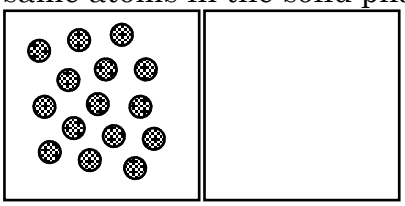
Name _____

Date _____ Pd ____

# Chemistry – Unit 1 Review

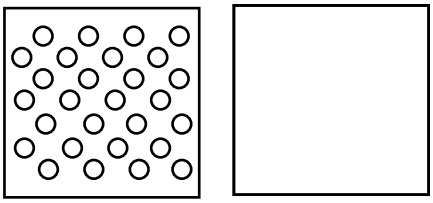
1. What is the difference between mass and volume?

2. If the box at left contains atoms of aluminum in the liquid phase, represent the same atoms in the solid phase in the box at right.

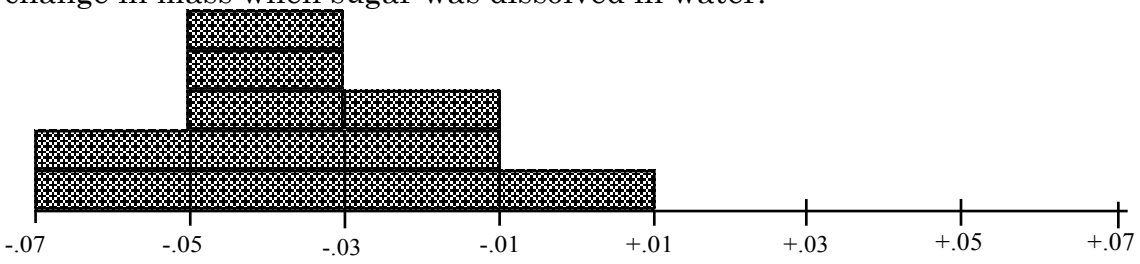


3. How would you represent the atoms of aluminum in the gaseous phase?

4. If the box at left contains atoms of iron in steel wool, represent what the atomic structure of the steel wool after strong heating in the box at right.

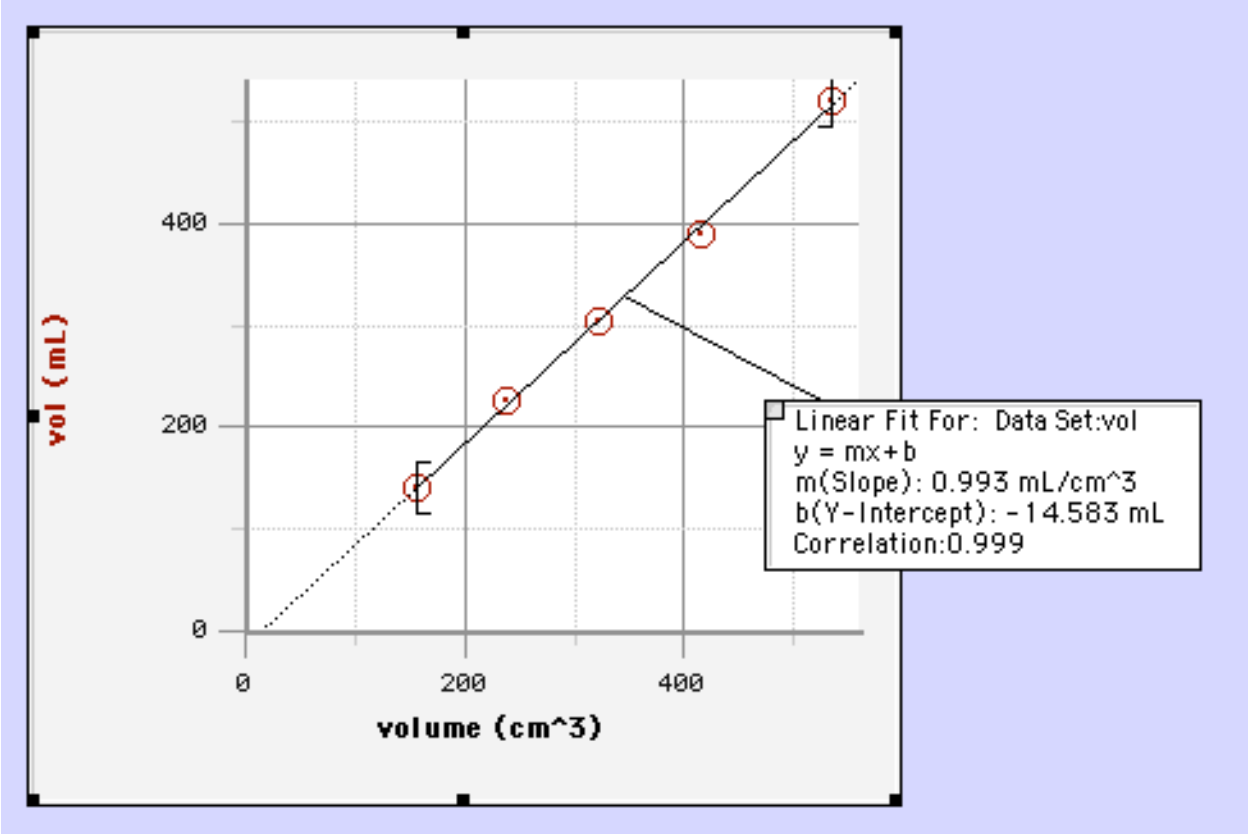


5. The 7th period chemistry class produced the histogram below to represent the change in mass when sugar was dissolved in water.




They concluded that the mass decreases slightly when sugar dissolves. Provide a better explanation.

6. The 8th period chemistry class produced the following graph when they plotted the volume of water in mL vs the volume of the container measured in cm^3.

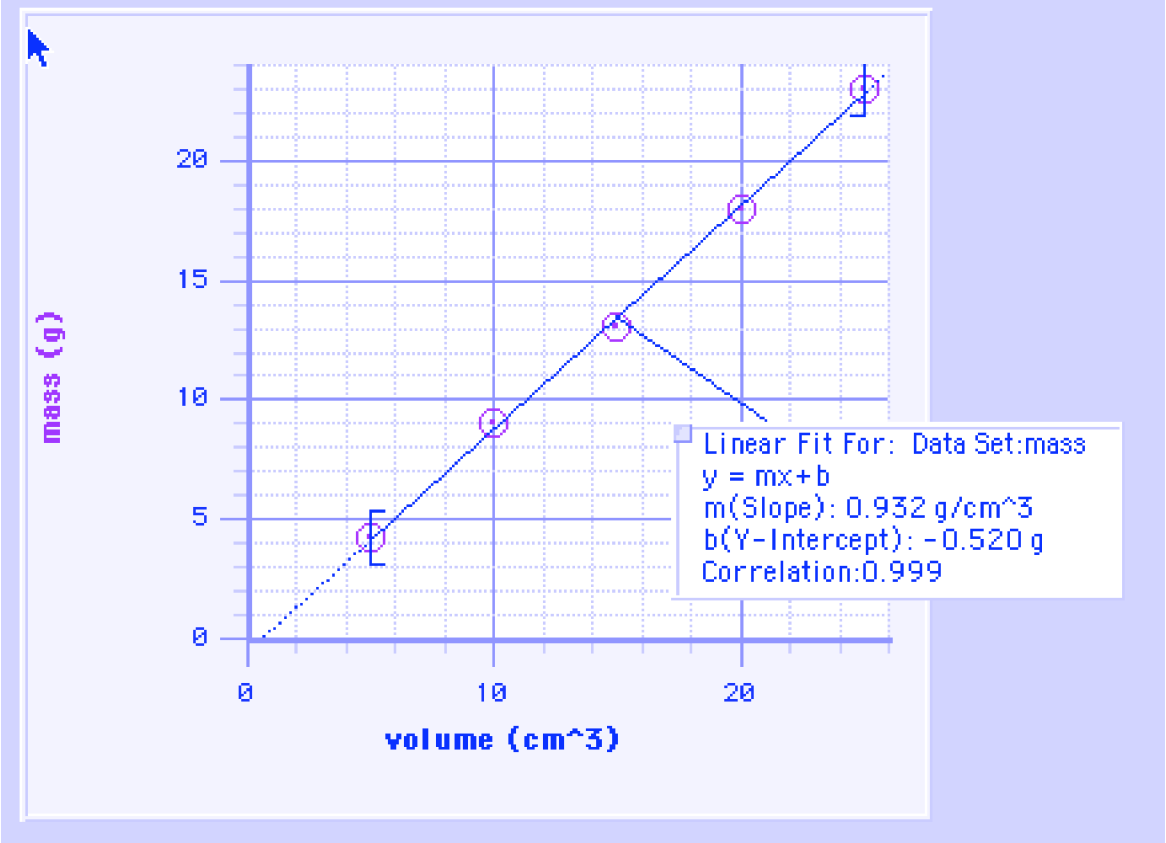



a. What does the slope tell you?

b. How could you account for the fact that they obtained a negative y-intercept?

c. Show, using the 5% rule, whether this intercept is negligible or must be explained.

7. The 9th Hr chemistry class produced the following graph when they were measuring the mass and volume of a set of objects in the lab.




a. Write the equation for the line.

b. What information is given by the slope of the graph?

c. Is the y-intercept negligible? Why or why not?

d. What would you predict would happen if you were to put one of the objects in water? Explain.

e. What would you expect to be the mass of a 45 $cm^3$ piece of the same substance

## Density Problems

8. Mercury has a density of 13.6g/mL. What is the volume occupied by 112.0 grams of mercury?

9. A cube of gold-colored metal with a volume of 54 $cm^3$ has a mass of 980 g. The density of gold is 19.3 $g/cm^3$. Is this sample of metal pure gold? Why or why not?